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ASD TECHNICAL REPORT 61-607

FAR FIELD NOISE AND VIBRATION LEVELS PRODUCED DURING THE SATURN SA-1 LAUNCH

(PRELIMINARY REPORT)

J. N. COLE

BIOACOUSTICS BRANCH
AEROSPACE MEDICAL RESEARCH LABORATORIES

AND

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ENVIRONMENTAL CRITERIA BRANCH
DEPUTY FOR TEST AND SUPPORT

DECEMBER 1961

AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

ASD TR 61-607

Aeronautical Systems Division, Aerospace Medical Research Laboratories and Deputy for Test and Support, Wright-Patterson Air Force Base, Ohio

FAR FIELD NOISE AND VIBRATION LEVELS PRODUCED DURING THE SATURN SA-1 LAUNCH (Preliminary Report), by J.N. Cole and C.E. Thomas. December 1961. 30p. incl. illus. (Proj. 7231; Task 723104)(Proj. 1309; Task 130905) Unclassified report

Acoustic measurements were made of the sound pressure level-time functions which were produced at six locations on Cape Canaveral Missile Test Annex (CCMTA) and at four locations in the surrounding communities

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DECEMBER 1961

PROJECT No. 7321
TASK No. 723104

PROJECT No. 1309
TASK No. 130905

AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

900 - March 1962 - 24-1009 & 1010

FOREWORD

This report was prepared by the Bioacoustics Branch, Aerospace Medical Research Laboratories, and the Environmental Criteria Branch, Environmental Division, Directorate of Engineering Test, Deputy for Test and Support, Wright-Patterson AFB, Ohio. The work was performed under AFSC Task 723104 entitled "Biodynamic Environments of Aerospace Flight Operations" and AFSC Task 130905 entitled "Measurement Analysis of Induced Environments." The data presented herein were measured by the Aeronautical Systems Division survey team at the request of the Directorate of Range Development (MTL) at Cape Canaveral Missile Test Annex, Air Force Missile Test Center, Patrick AFB, Florida. This project was supported under Atlantic Missile Range Operations Directive 058.

This information is included in a more comprehensive report, ASD Technical Report 61-608, "Acoustic Noise and Vibration Studies at Cape Canaveral, Florida," containing noise and vibration data, correlations, and generalizations obtained from the study of twenty-four launch operations measured at CCMTA during the period of 7 July 1961 through 17 November 1961.

ASD personnel who participated in this survey and in the writing of this report are: J.N. Cole, R.T. England, H.K. Hille, and R.G. Powell of the Bioacoustics Branch; and R.P. Boyd, G.A. Plzak, H.K. Reich, and C.E. Thomas of the Environmental Criteria Branch.

The authors wish to express their appreciation to the many organizations that supported this study program, including: the Directorates of Range Development (MTL) and Range Operations (MTR), the Air Force Missile Test Center, Patrick AFB, Florida; Pan American Airways, Inc.; and the Radio Corporation of America.

ABSTRACT

Acoustic measurements were made of the sound pressure level-time functions which were produced at six locations on Cape Canaveral Missile Test Annex ~~(CCMTA)~~ and at four locations in the surrounding communities during the Saturn SA-1 launch ~~on 27 October 1961~~. The frequency range of measured data was from the 4.7 to 9.4 cps octave band to the 4800 to 9600 cps octave band. Distances from the launch site to the noise measuring sites ranged from 3700 to 100,000 feet. Vibration data were taken at three locations at the Tel-2 telemetry site. The frequency range of measured data was from the 4.5 to 9 cps octave band to the 1125 to 2250 cps octave band. The distance from the launch site was 5200 feet. Only the basic sound pressure level-time environments and vibration level-time environments as a function of octave bands of frequency are presented in this report.

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INTRODUCTION

The purpose of this report is to make available in preliminary form the noise and vibration data obtained by the Aeronautical Systems Division (ASD) Survey Team during the Saturn SA-1 launch on 27 October 1961. These data represent part of a larger effort to define the dynamic environment produced by this launch. Other organizations participating in this overall program were NASA Marshall Space Flight Center and the U.S. Coast & Geodetic Survey. The information presented herein represents only the ASD Survey Team's contribution to the total effort.

Noise measurements were made at 10 sites at Cape Canaveral Missile Test Annex (CCMTA) and in the surrounding areas. These sites (Figure 1) included six locations within the controlled area and four locations outside CCMTA.

Acoustic instrumentation at each site included an Altec condenser microphone with windscreen, a Western Electro-Acoustics preamplifier and microphone complement, and a line amplifier and matching network to put data signal onto a line for transmission to a centralized ASD Mobile Acoustics Recording facility located adjacent to Central Control. The transmission lines were, in most cases, 125-ohm balanced wide-band lines. All data were recorded on magnetic tape with Ampex 307 series recorders with 7 channels of FM and 14 direct recording channels being available. A switchable bank of Khron-Hite variable band pass filters and a Bruel and Kjaer Model 2305 graphic level recorder were used for data reduction.

Vibration measurements were made at three locations at Tel-2: (1) Pod of TLM-18 antenna, (2) Dish Reflector of TLM-18 antenna, (3) Steerable Tri-Helix Number 4. The equipment used to perform these measurements were Endevco accelerometers, Model 2607. Three directions of vibration were monitored at each point thus giving 9 channels of data. These data were recorded on a Davies Model 501 14-channel tape recorder. This recorder is an FM type having an FM carrier of 10 KC and an intelligence frequency response of 3-2000 cps with a dynamic recording range of 45 db. Vibration data were analyzed by the Environmental Branch's data reduction system at Wright-Patterson Air Force Base.

These Saturn launch data are included in a more comprehensive report, ASD Technical Report 61-608, "Acoustic Noise and Vibration Studies at Cape Canaveral, Florida," on the results of a 5-month measurement program by ASD. During this time noise and vibration measurements were made on twenty-two launches at CCMTA: eight Titan; seven Atlas, one Delta, one Minuteman, two Pershing, one Polaris, one Bluescout, and one Jupiter.

This report discusses in detail the measurement methods, instrumentation, and especially the correlation and significance of the data results presented.

SECTION II

PRESENTATION OF DATA AND CONCLUSIONS

The sound pressure level (SPL) environments at each of the 10 sites are given as functions of time on figures 2 through 11 and vibration levels on three locations at Tel-2 are presented on figures 12 through 20. These figures show the octave band SPL's versus the time in seconds from launch over the frequency range of 4.7 to 9600 cps, and vibration levels versus time over the frequency range of 4.5 to 2250 cps. Time is referenced to the range zero which is the first whole second before first motion of the vehicle. The recorder used in vibration data acquisition had a cut-off at 2000 cps and the time history plots of the 1125 to 2250 octave band are from 0 to -1 db in error due to this cut-off.

The effective averaging time used to smooth the SPL-time plots was approximately 3 seconds. Short-time variation of those levels using much shorter averaging times are given in ASD Technical Report 61-608.

We concluded from this preliminary study that the estimated sound pressure levels, necessary for data acquisition, were usually within 5 db of those expected.

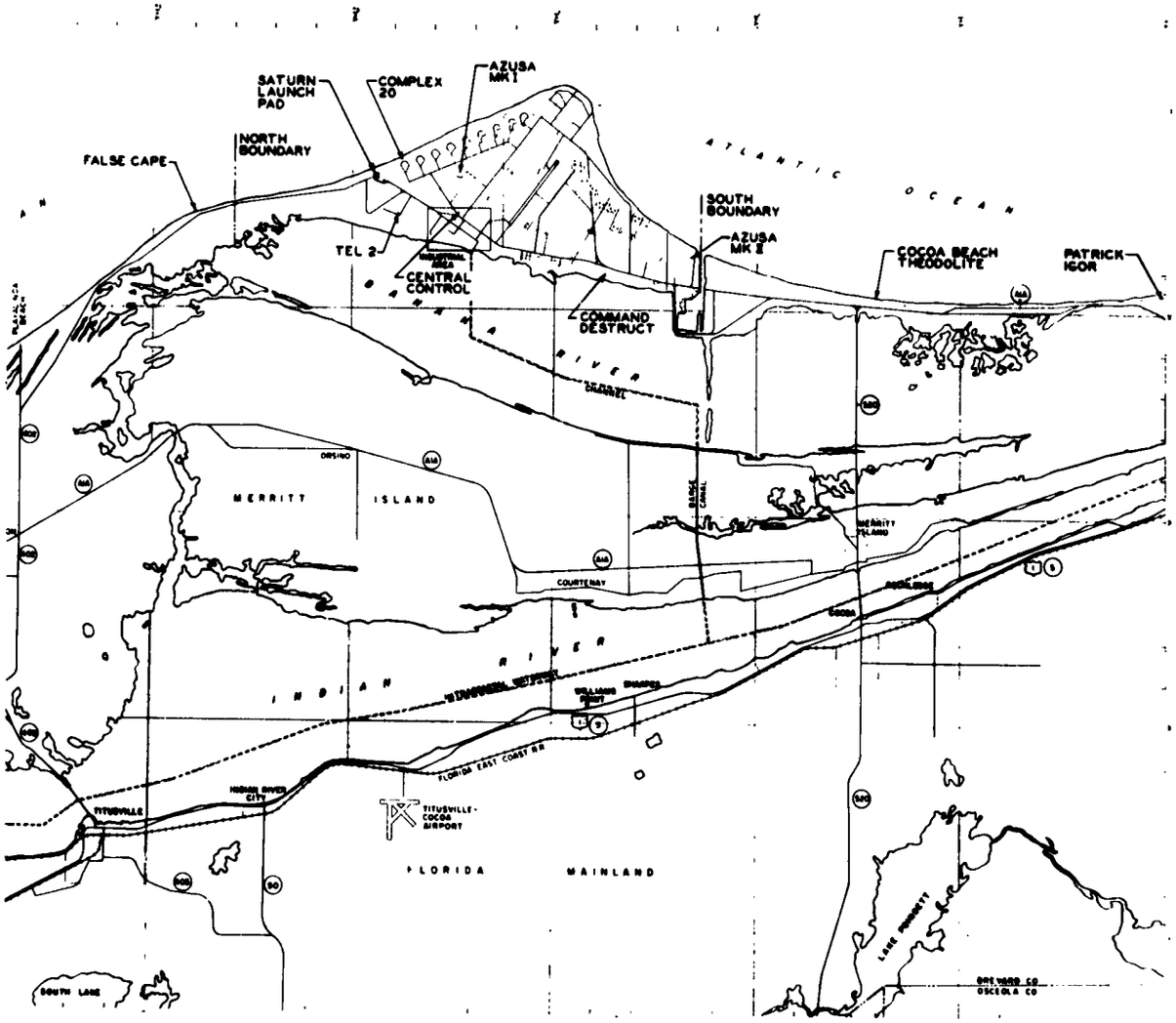

Figure 1. Location of Measurement Sites

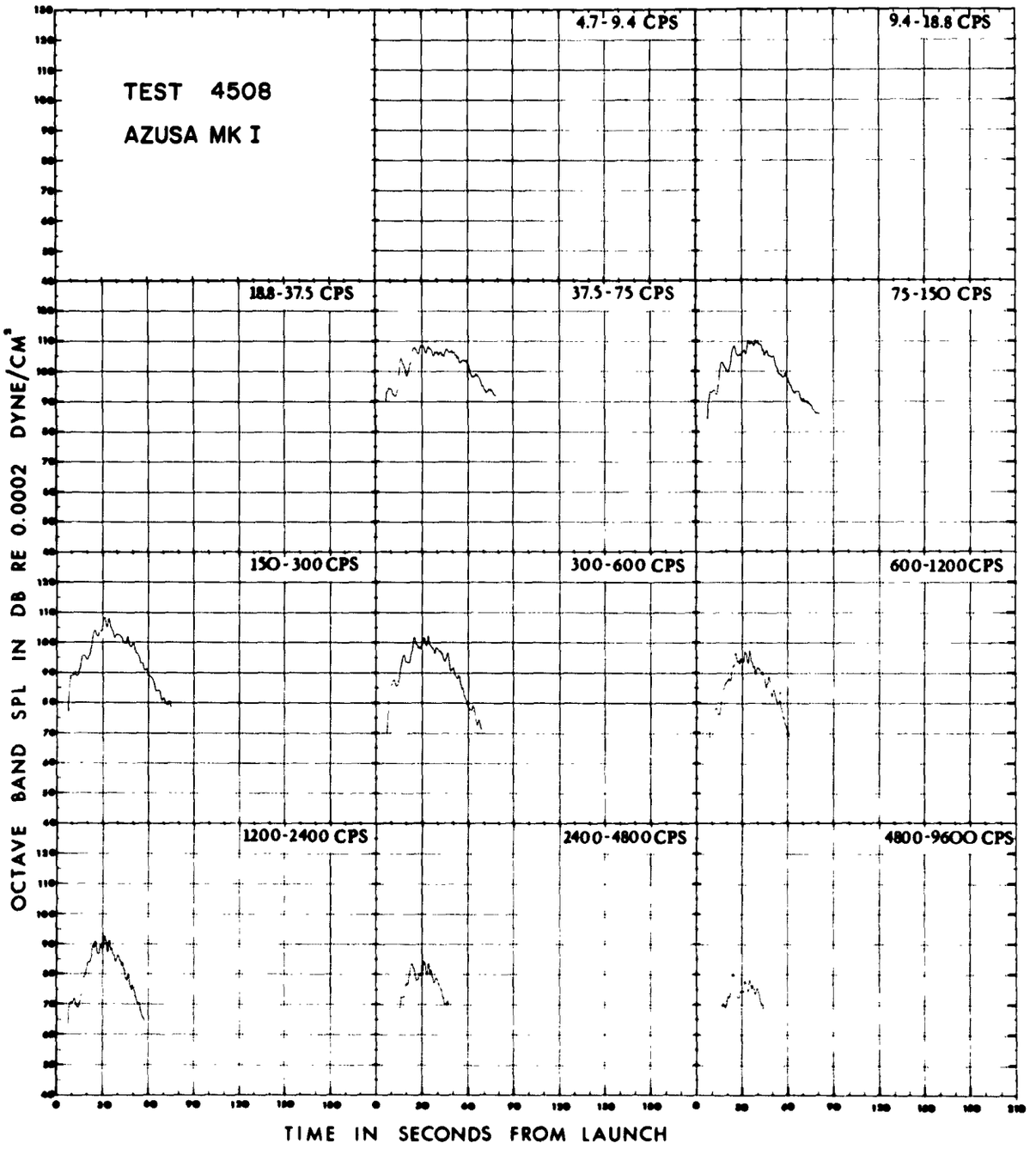

Figure 2. Octave Band SPL's at Azusa Mk I as a Function of Time

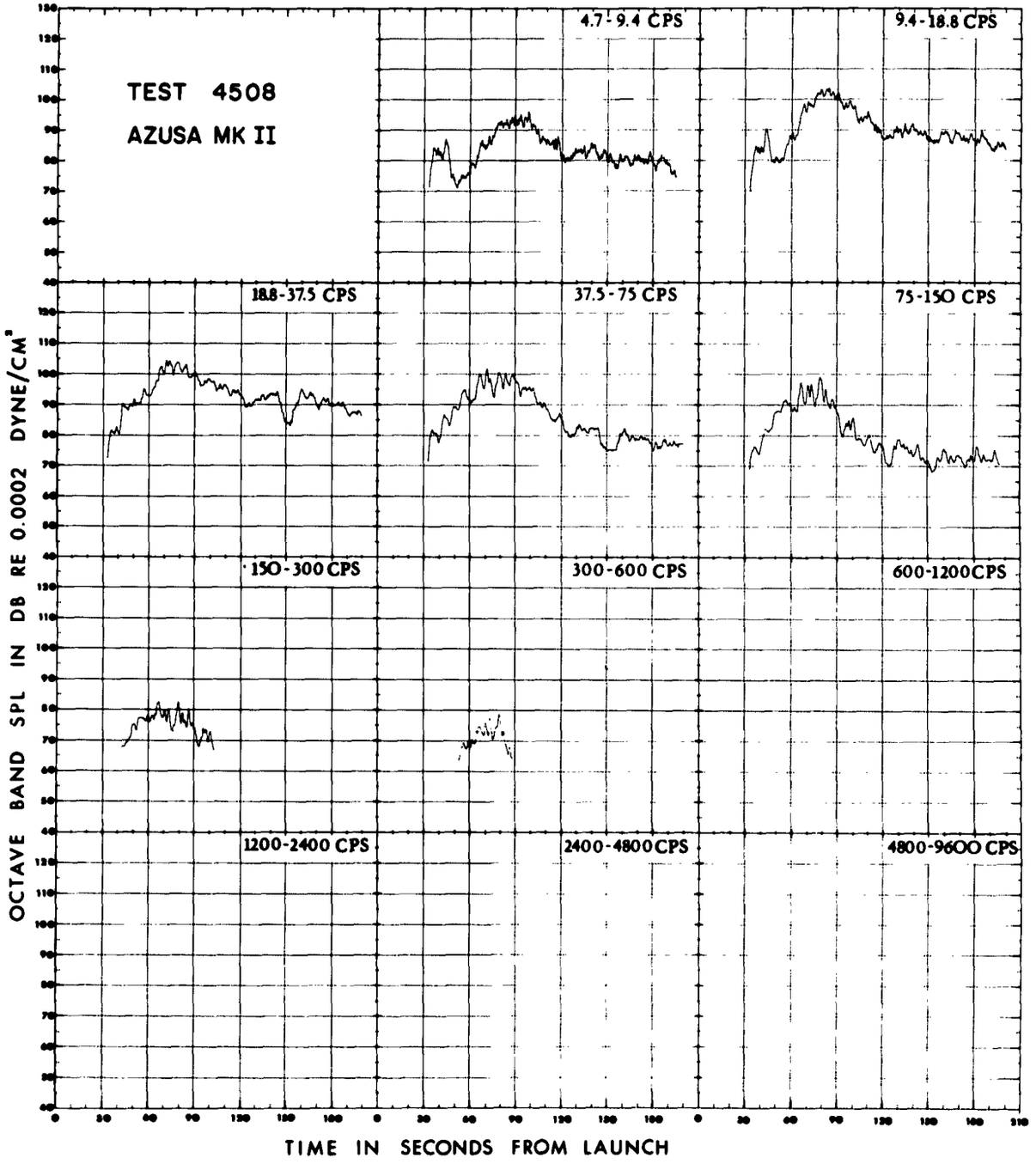

Figure 3. Octave Band SPL's at Azusa Mk II as a Function of Time

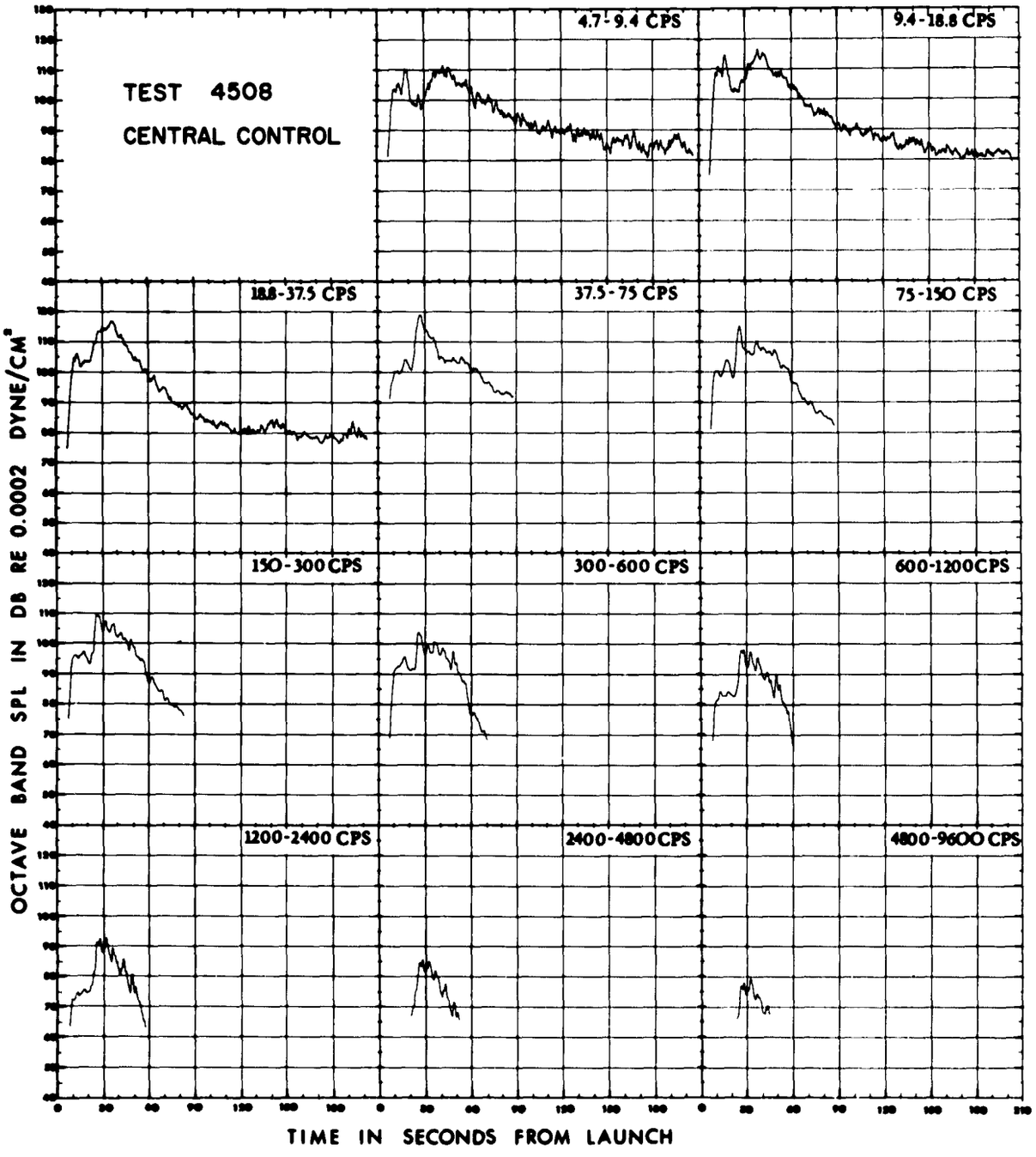

Figure 4. Octave Band SPL's at Central Control as a Function of Time

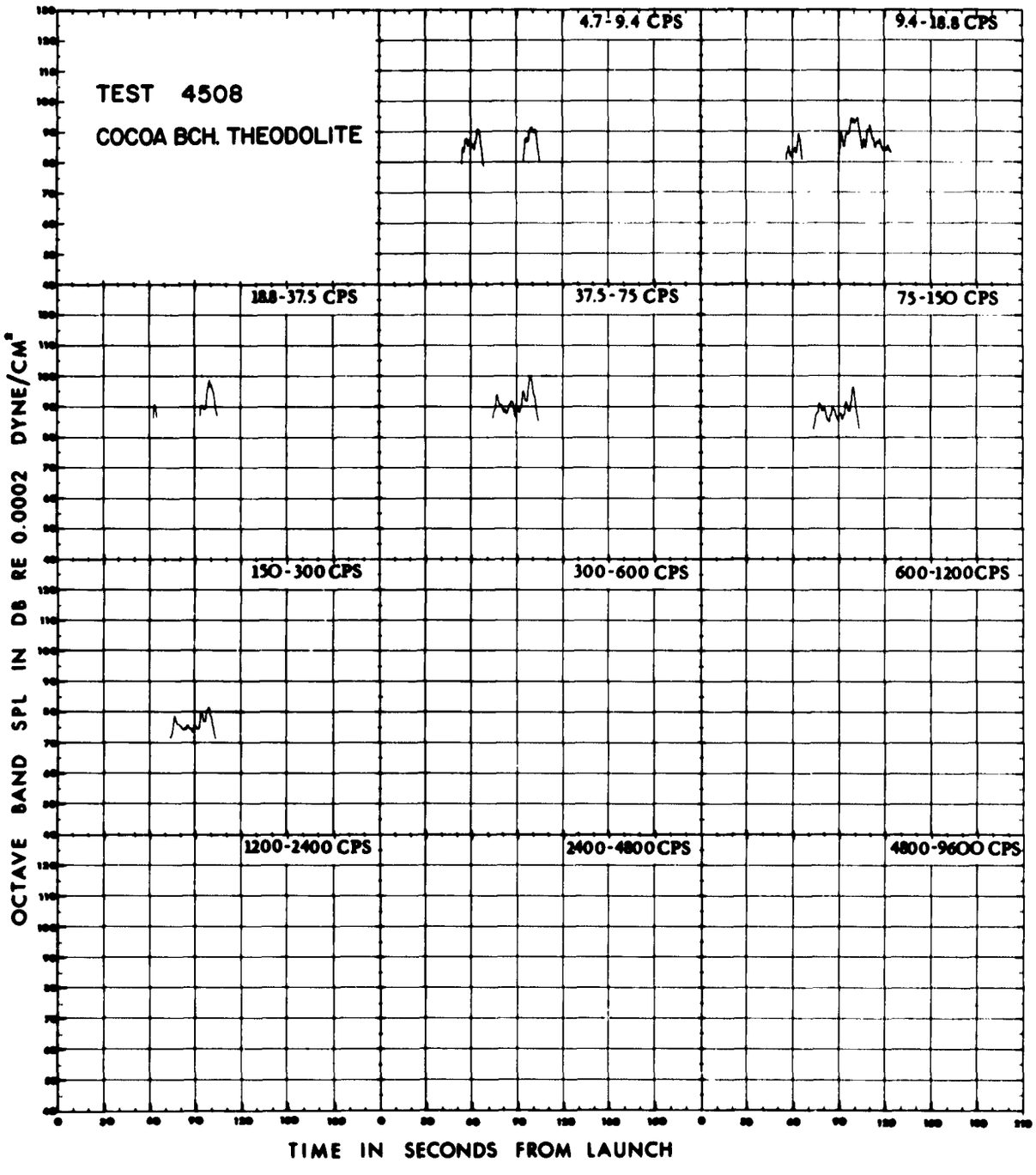

Figure 5. Octave Band SPL's at Cocoa Beach Theodolite as a Function of Time

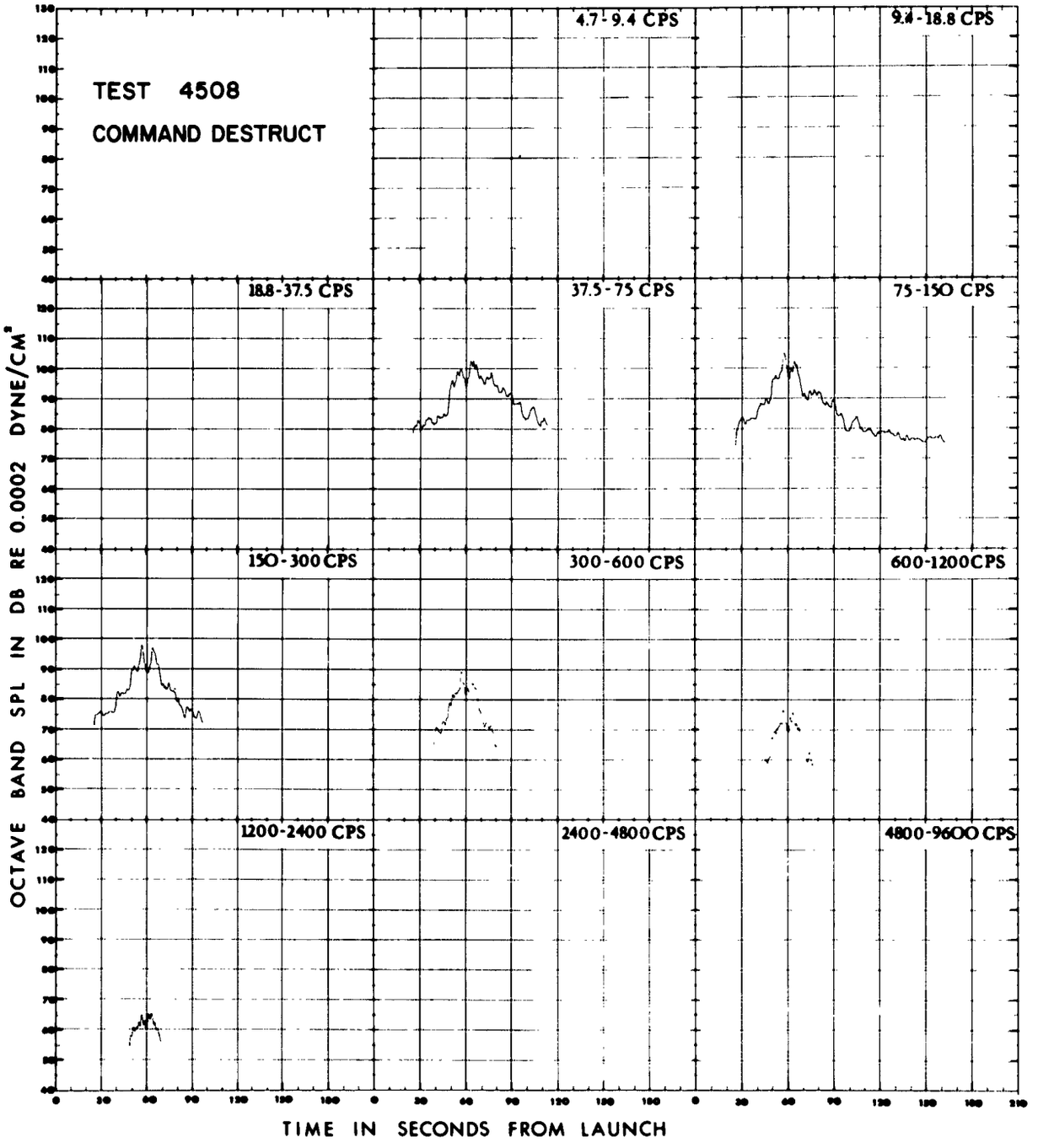

Figure 6. Octave Band SPL's at Command Destruct as a Function of Time

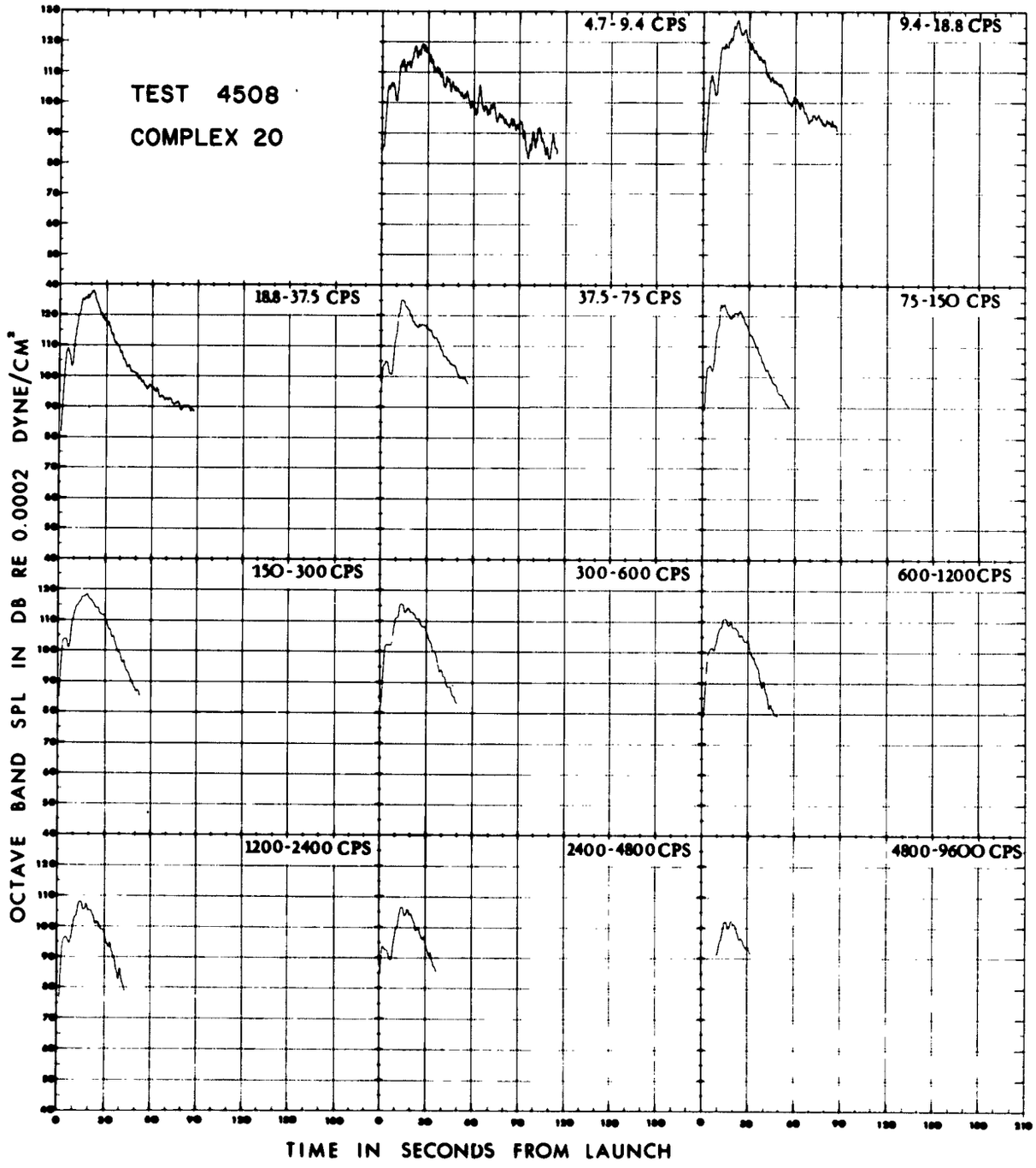

Figure 7. Octave Band SPL's at Complex 20 as a Function of Time

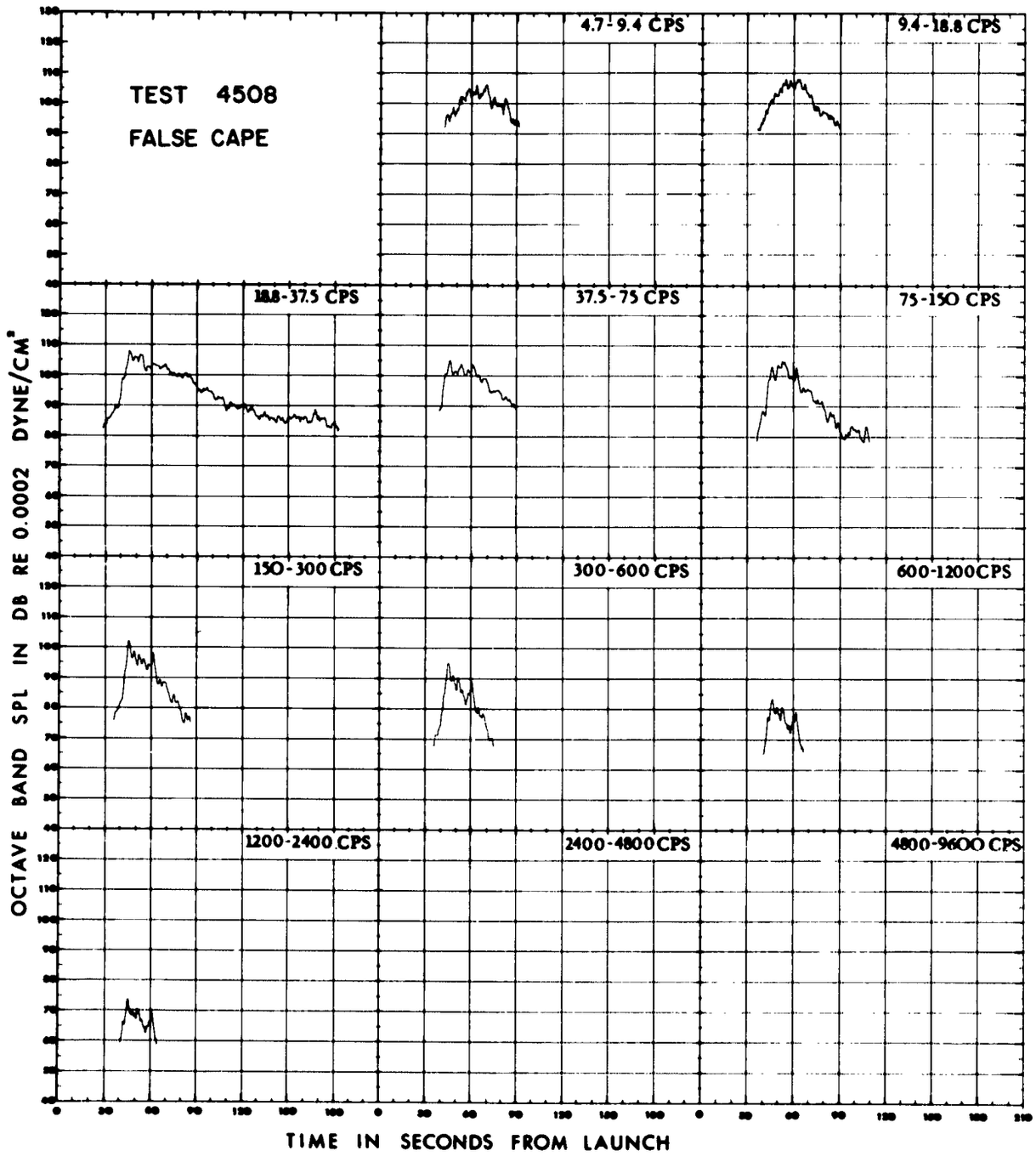

Figure 8. Octave Band SPL's at False Cape as a Function of Time

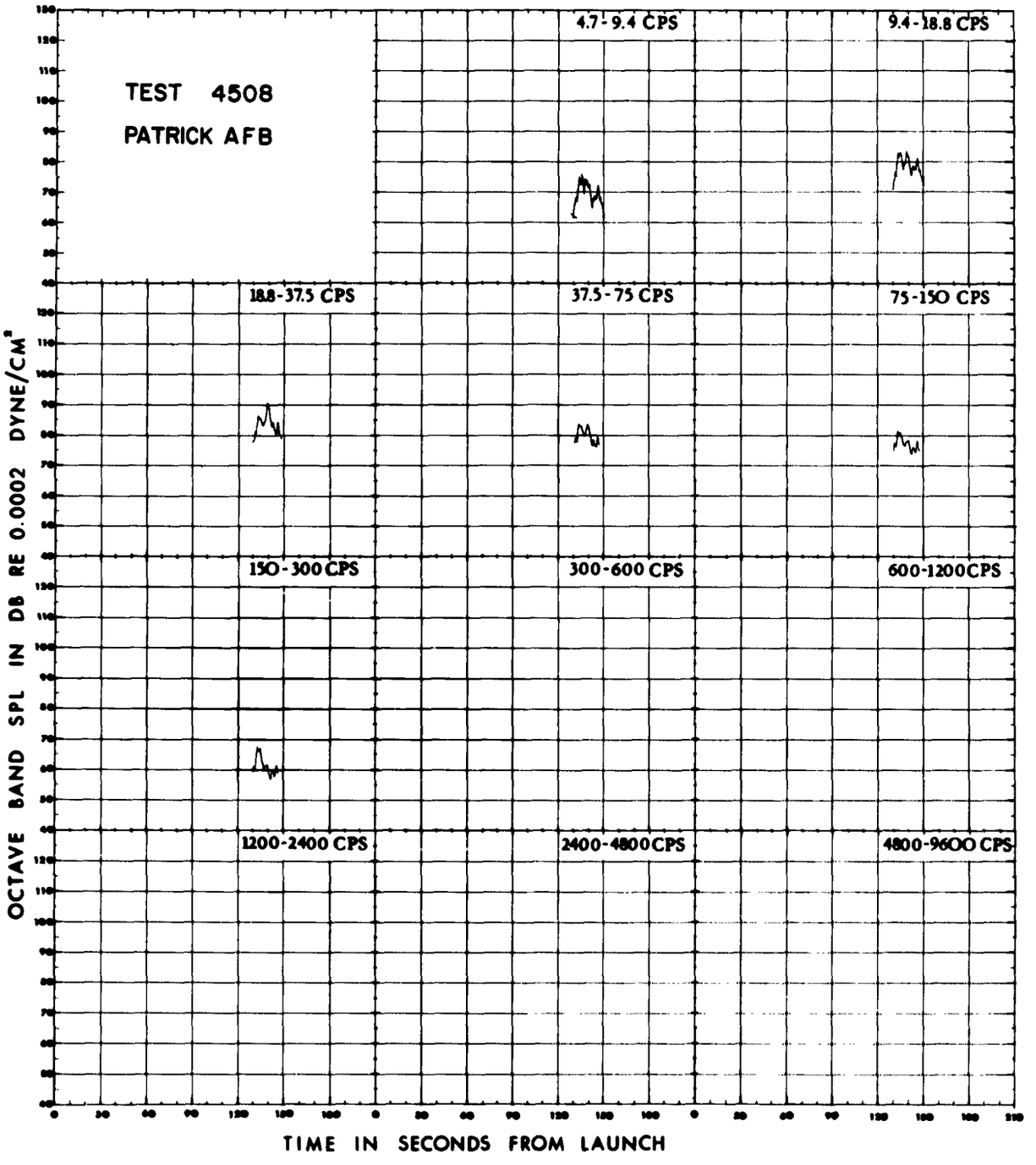

Figure 9. Octave Band SPL's at Patrick AFB as a Function of Time

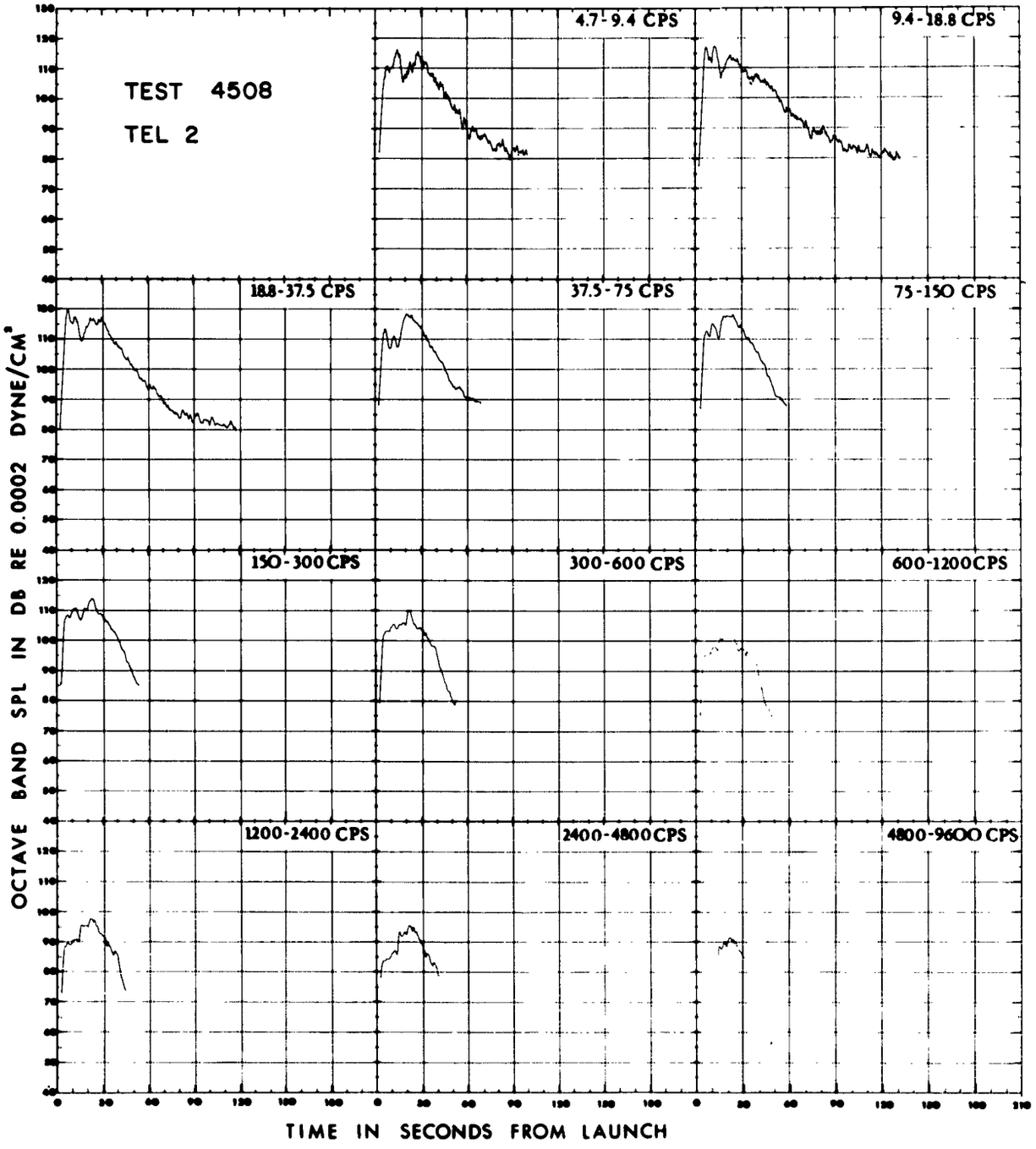

Figure 10. Octave Band SPL's at Tel 2 as a Function of Time

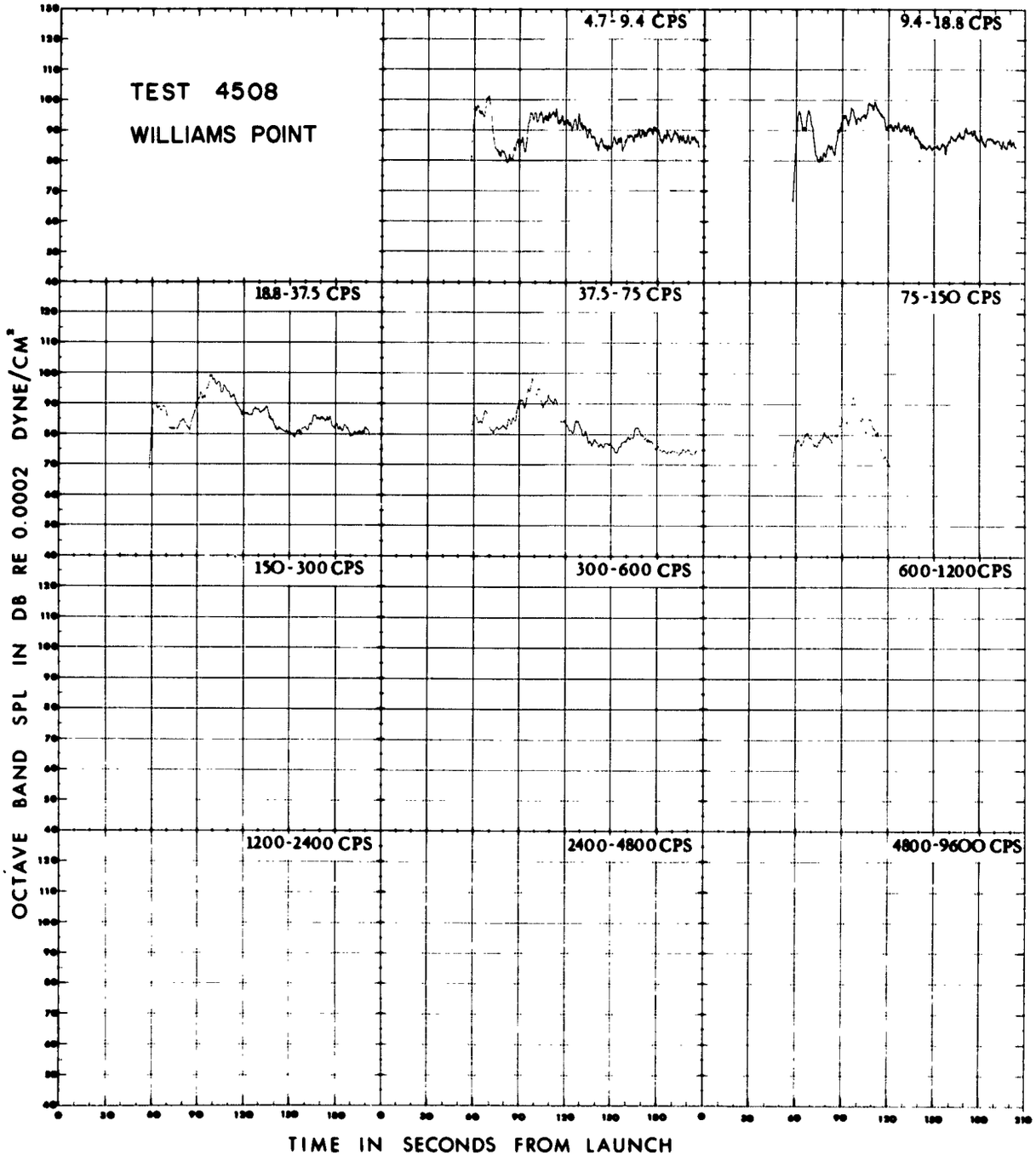

Figure 11. Octave Band SPL's at Williams Point as a Function of Time

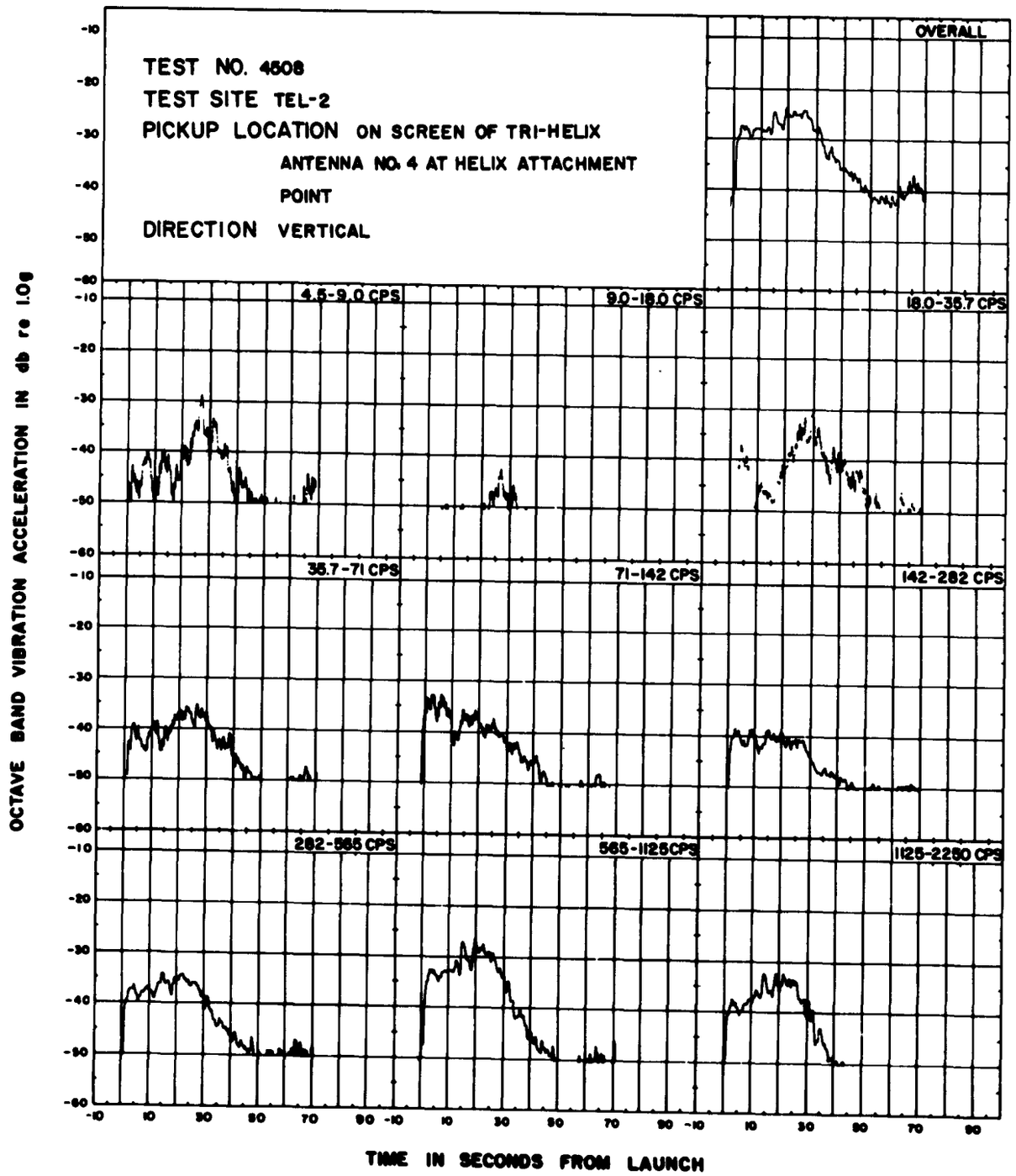

Figure 12. Octave Band Vibration on Screen of Tri-Helix, Vertical Direction

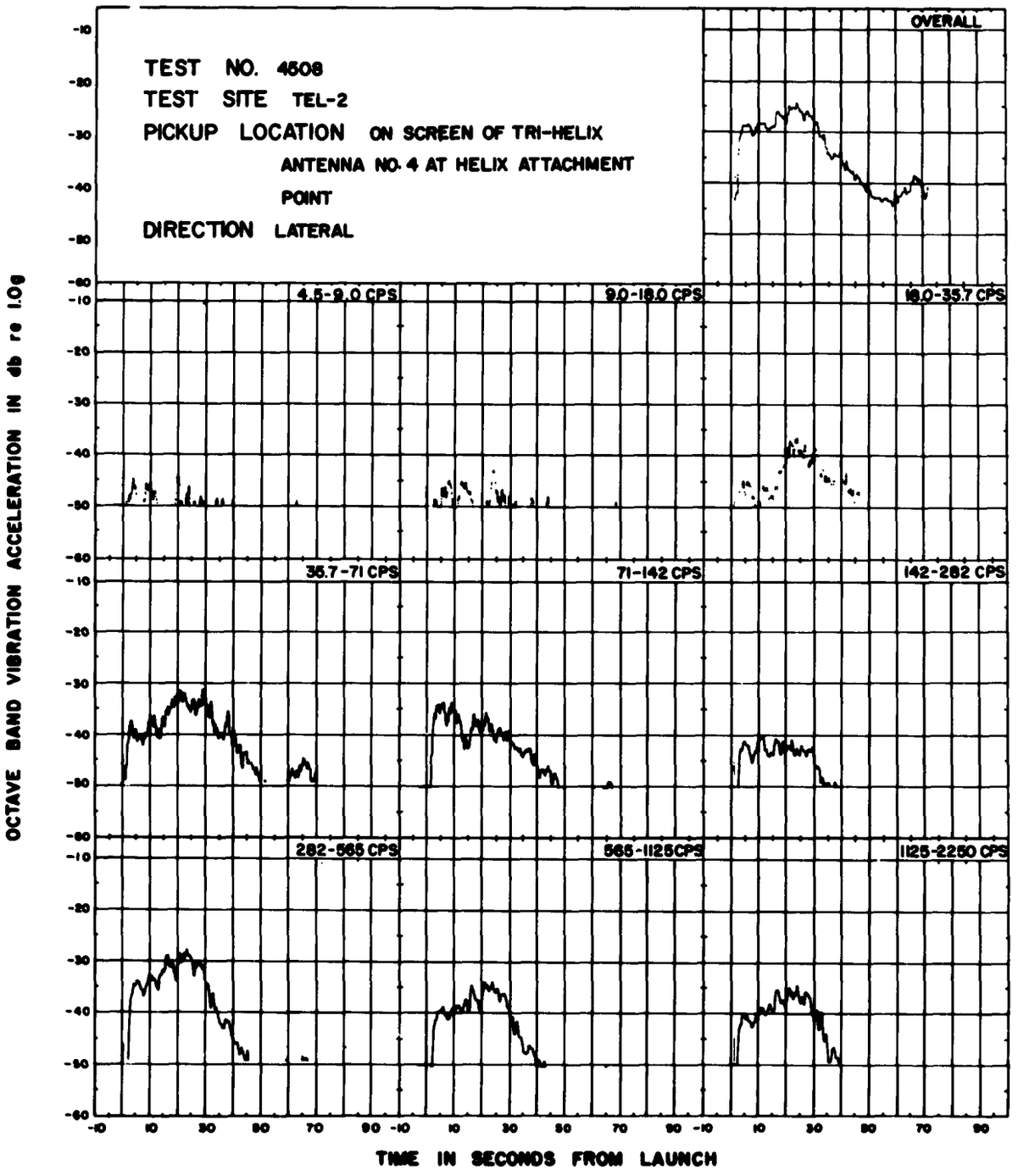

Figure 13. Octave Band Vibration on Screen of Tri-Helix, Lateral Direction

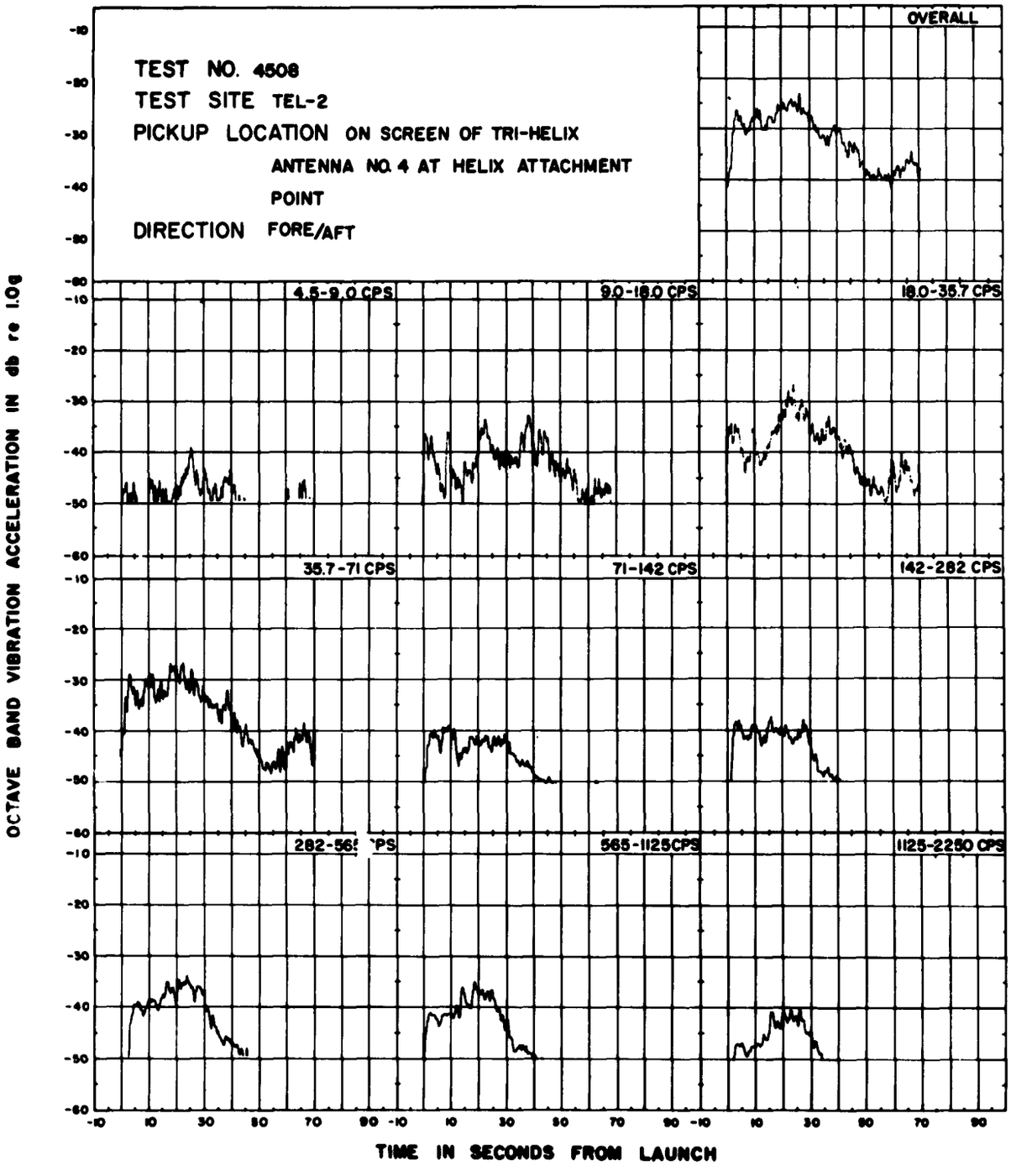

Figure 14. Octave Band Vibration on Screen of Tri-Helix, Fore/Aft Direction

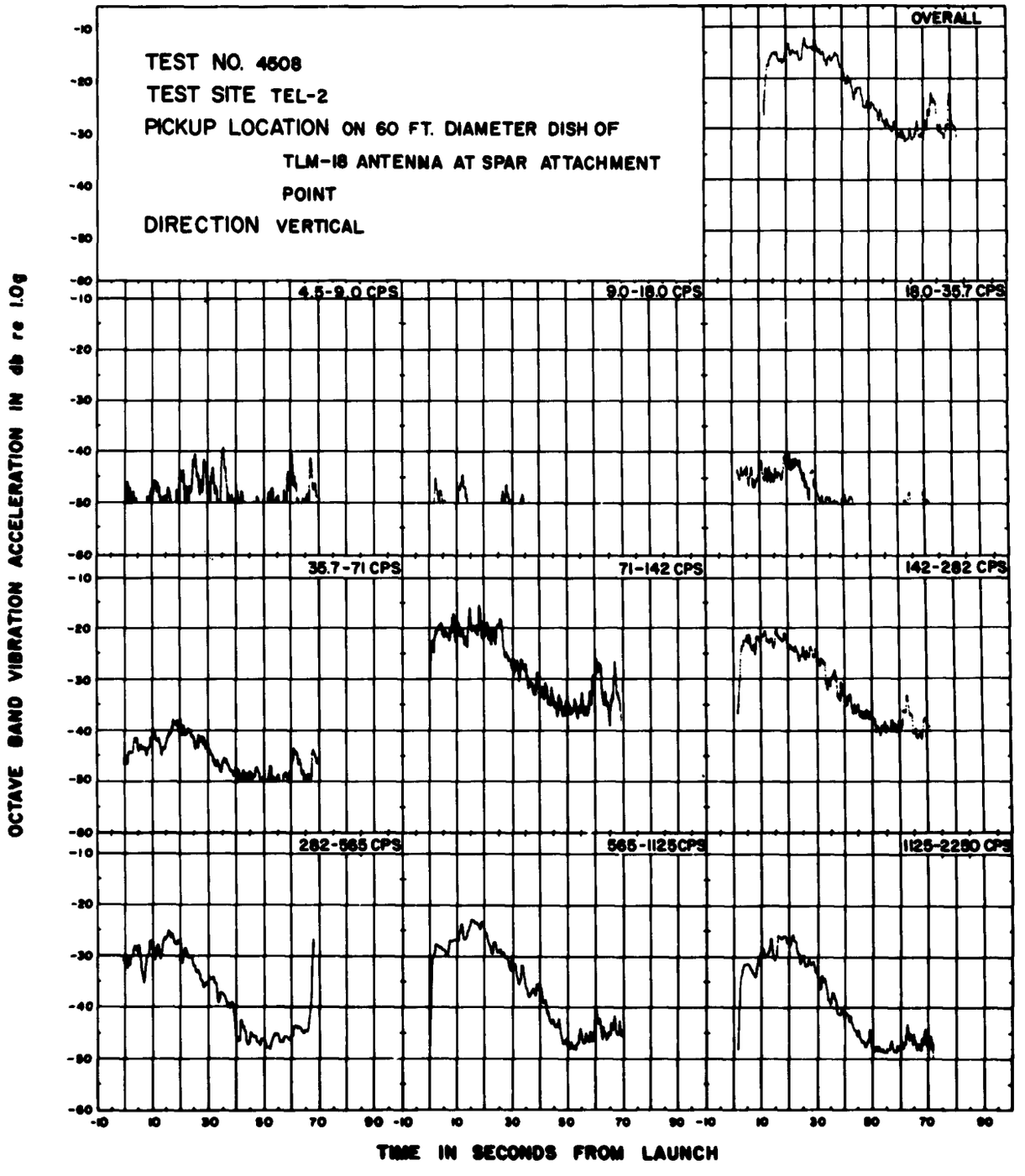

Figure 15. Octave Band Vibration on 60 ft. Dish of TLM-18, Vertical Direction

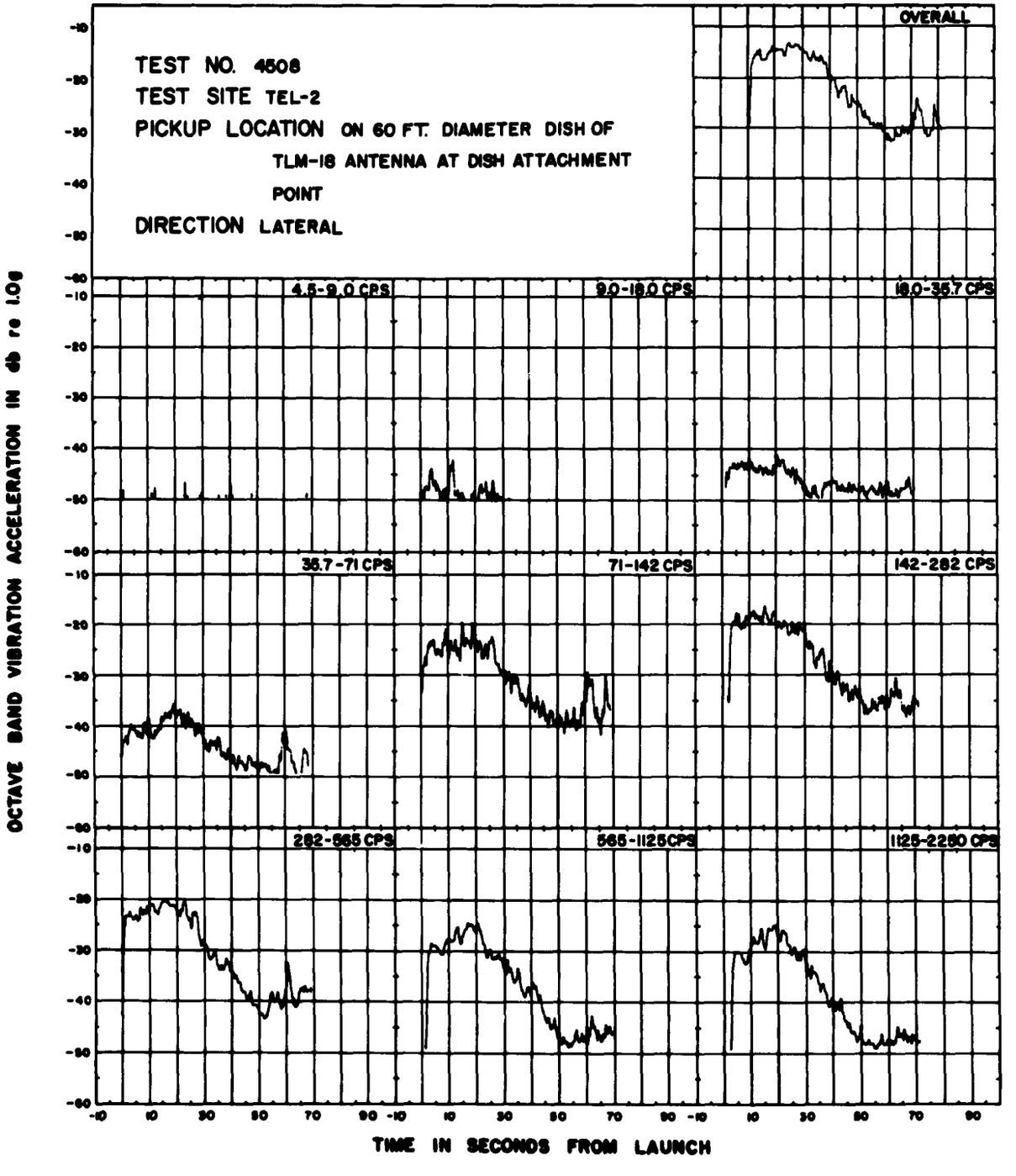

Figure 16. Octave Band Vibration on 60 ft. Dish of TLM-18, Lateral Direction

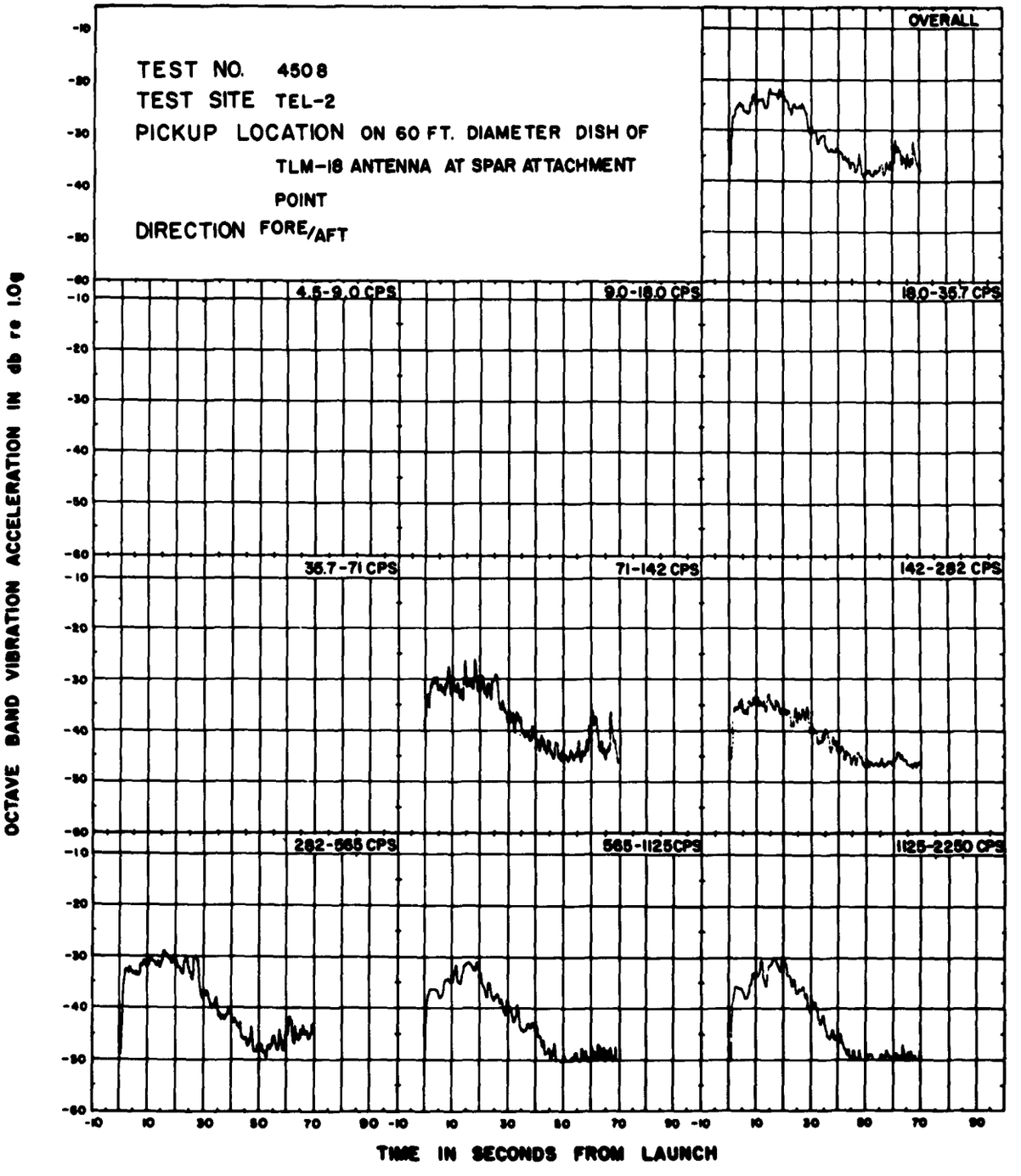

Figure 17. Octave Band Vibration on 60 ft. Dish of TLM-18, Fore/Aft Direction

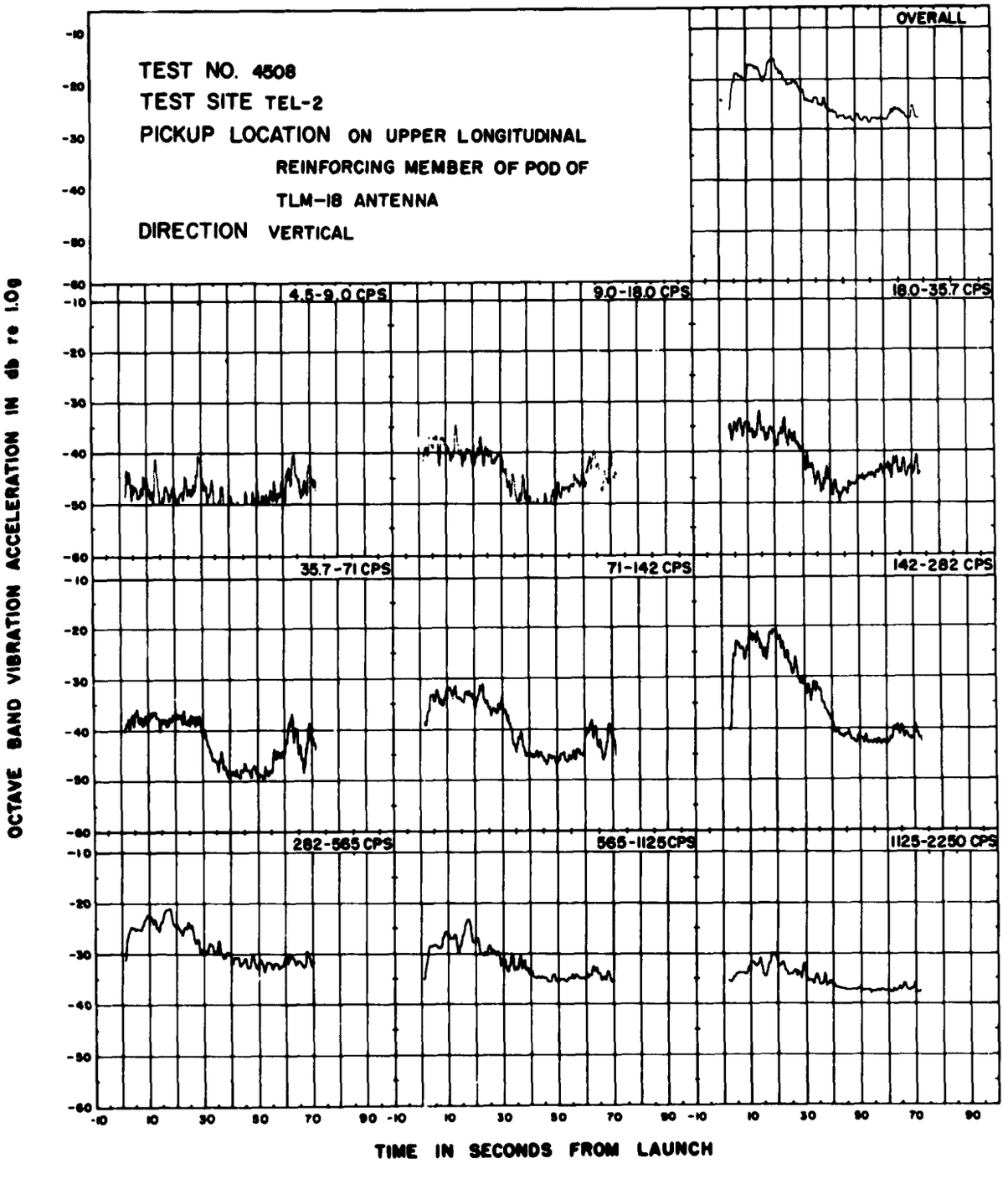

Figure 18. Octave Band Vibration on Pod of TLM-18 Antenna, Vertical Direction

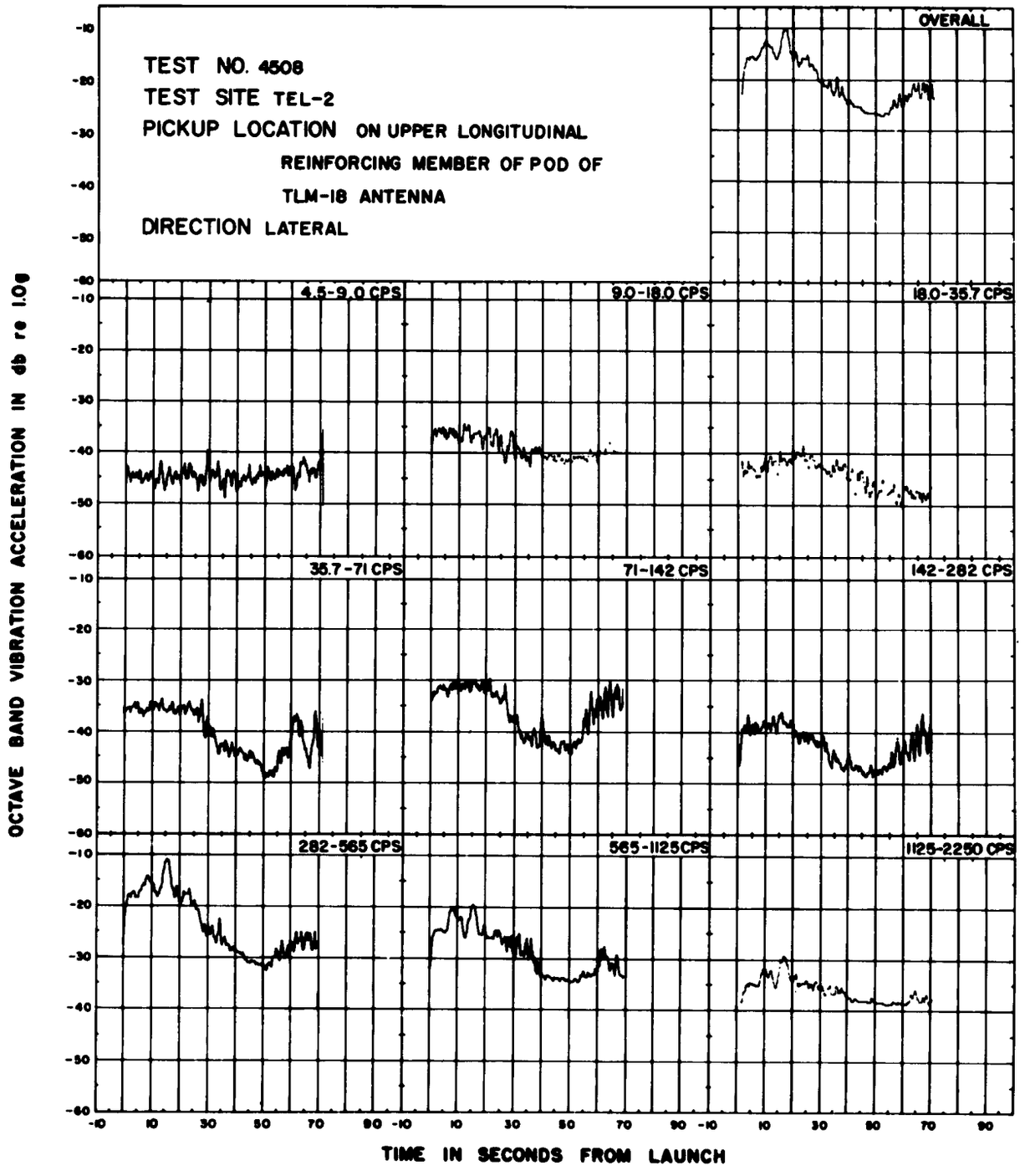

Figure 19. Octave Band Vibration on Pod of TLM-18 Antenna, Lateral Direction

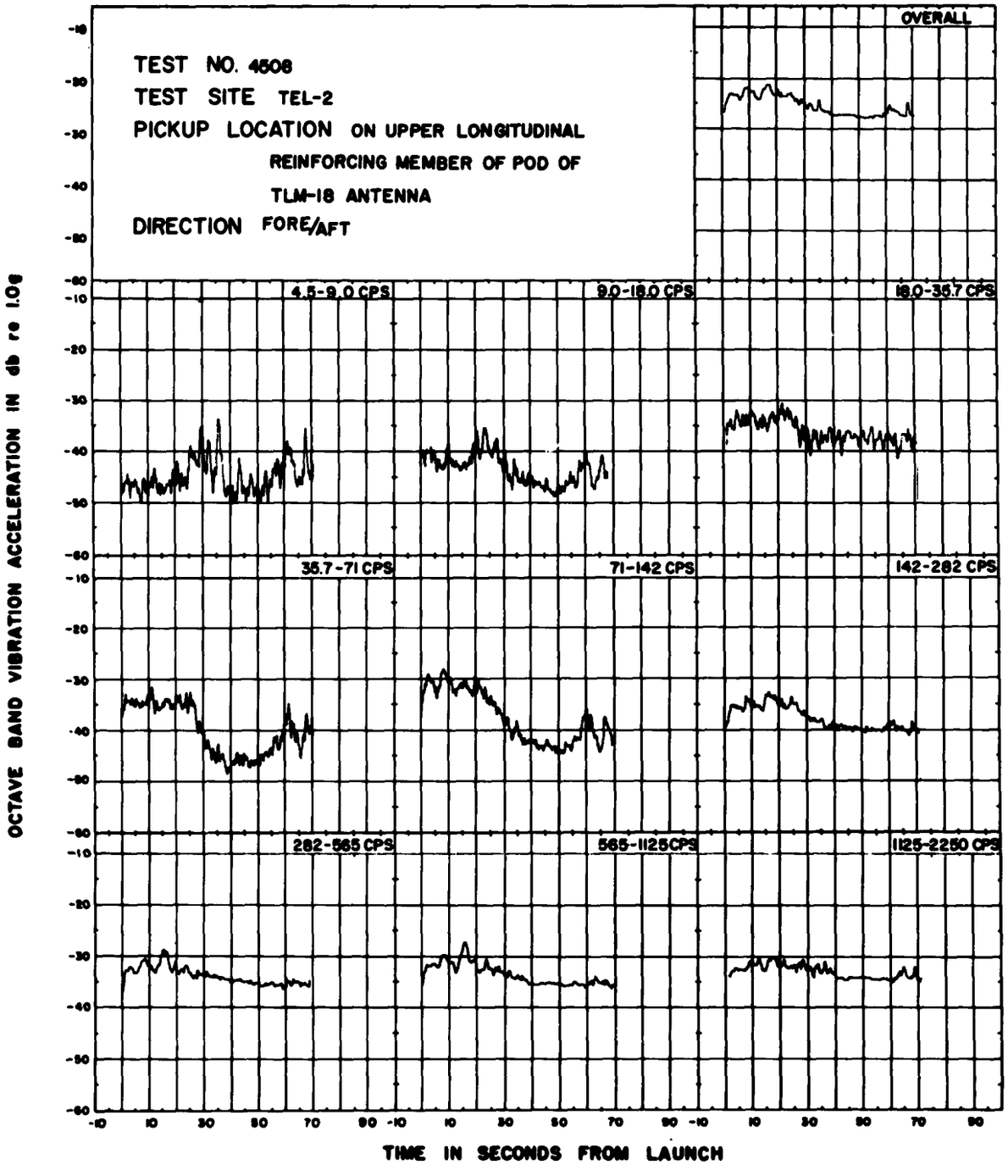

Figure 20. Octave Band Vibration on Pod of TLM-18 Antenna, Fore/Aft Direction